

January 2003

03-1

IT IS TIME TO PAY MEMBERSHIP DUES

The next meeting of the London Chapter will be Thursday February 13, 2003. It's *Members Speaker Night*. Come and join in the fun! Steve Timmermans, Holly Martelle, Jim Keron and Chris Ellis will be presenting.

On Thursday March 13th, the speaker will be Dr. Kelly Olson of the Classical Studies Department, UWO. Dr. Olson was to have presented her talk on Roman plumbing, **Roman Sewage and Social Relations**, in January, but illness prevented her attendance.

As always, our meeting will be held at 8 pm at the London Museum of Archaeology, 1600 Attawandaron Road, near the corner of Wonderland & Fanshawe Park Road, in the northwest part of the city.

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ANNUAL RATES

Individual.....	\$18.00
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COMPARABILITY OF PUBLISHED DEBITAGE ANALYSIS: AN EXPERIMENTAL ASSESSMENT

James Keron

In the last few years, it has become standard for archaeological reports to include a section analyzing the debitage from the site. Early pioneers in this field locally were Chris Ellis, Paul Lennox and Bill Fox but recently this has become a standard part of a CRM report. So we now have published data from a number of sites that should allow comparison between them.

In theory one need only pull the material from the published reports and then proceed to the comparison although there might be some difficulty in gaining access to CRM reports on file at the ministry given the trade secrets contained in these reports. However, anything more than a cursory examination of these reports reveals a number of problems. First, closer examination reveals that a number of different flake typologies are used that frequently use different names for the same thing and the same names for different items (e.g. Primary vs Secondary). Further, some typologies are more detailed than others (see Ellis 1984 vs Lennox 1986). While the Lennox (1986) typology has become a *de facto* standard amongst a number of CRM firms, it is an open question whether it is being applied in the same way (i.e. does the same flake always receive the same classification). Of even more interest is the extent to which an analysis of any given researcher is replicable by other researchers. If Analyst A says a site has 20% Kettle Point chert and Analyst B says a second site has 30% Kettle Point chert, is this a meaningful difference? If they analyzed each others sites would the percentages stay the same?

In order to consider these questions an experiment was conducted whereby several analysts classified the same set of 200 pieces of debitage taken from two Iroquoian sites in the London area. The goals of this exercise were as follows.

1. To gain an insight as to the replicability of flake typology and chert source classification and assess the extent of inter-observer variability.
2. Based on these results, to understand the extent to which published data from different sources can be used for comparative analysis.

TYPOLOGIES IN ONTARIO

In the London area several different stage typologies have been used in the past and in the subsequent discussion will be labeled by the name of the analyst. These four typologies have an interrelated genealogy. The two original typologies are those of Chris Ellis (1984) which was developed for work with Paleoindian assemblages and that of Paul Lennox (1986) which evolved through work on Iroquoian sites and consulting work. The third typology, that of the author (Keron, 1986) was developed following Lennox (1982) but was modified through discussions with Ellis. The fourth typology, that used by Peter Timmins in his Ph.D. Thesis (1997) was developed with influence from Keron (1986) and Ellis (1984). Subsequently, Timmins used Lennox's typology while working with the MTC and further the London Museum of Archaeology has also adopted

Lennox's typology (R. Pearce: personal communication, 1999).

With the exception of Ellis's typology, the others are similar to each other and a comparison of all these typologies can be found in Figure 1. In this figure, reduction proceeds from left to right with core reduction on the left and tool resharpening on the right. The various types can be compared along any given vertical sequence. Timmins' and Keron's are most comparable while Lennox's is a little simpler (i.e. fewer types) and Ellis's is much more detailed as he was dealing with highly regularized Paleoindian knapping patterns. Areas hatched out indicate that a comparable category was not defined in that typology. For example, the published description of Keron (1986: 142) and Lennox (1986: 225) do not include a type for unifacial retouch although this may be just an oversight. Note that the area in Deller and Ellis (1992) which is not defined is the core reduction sequence that was not present at Thedford II. They are defined in Ellis (1984) but have not been included here.

In examining Figure 1, some of the criticisms noted earlier seem to apply. Despite the inter relatedness of the typologies, the different analysts use different terms for similar types (Keron's cortex and Timmins primary), the same terms for different types (Timmins and Lennox's secondary) as well as overlapping types (Keron's biface and Timmins resharpening and biface thinning). Generally, shatter and flake fragments are identical throughout. Ellis's typology being composed of a larger number of types maps well into the other three types.

THE EXPERIMENT

In order to validate replicability and understand the extent to which published analyses could be compared, a short experiment was conducted. This involved circulating a collection of lithic debitage to six different analysts each of whom then independently analyzed the material and recorded their observations. Of the people who agreed to participate four have been involved in lithic analysis in the past and two others had not, and indeed, this was their first attempt to work with these typologies. Only the names have been changed to protect the innocent.

The set of 200 pieces of debitage was selected from two London area Iroquoian sites, the Cassandra Site (AfHh-65) and Dorchester Village (AfHg-24) (both Keron 2000). Two sites were used as each had a high frequency of different chert types. Cassandra is a late prehistoric Neutral village or large hamlet (1 hectare) in the Lambeth area and Dorchester is a large (1.5 hectare) Uren substage village located on the edge of the village of Dorchester.

These samples were chosen as the flakes all resulted from a controlled surface pickup (CSP) and consequently had a unique catalog number on each so that they could easily be handled without consuming excessive time opening and resealing bags of unnumbered flakes. Further, by recording the type of each numbered flake, it is possible to compare how each analyst typed each individual flake not just the overall frequency in the total collection.

For typological classification, analysts were requested to assign a type for both Lennox's and Timmins' typology. The reason for including two typologies was that Timmins' had more

categories and the intention was to see whether the more complex typology could be replicated between the observers. To guide the analysts the appropriate sections of the published descriptions (Lennox 1986 and Timmins 1997) were photocopied and distributed with the instructions. One slight modification was requested to Timmins typology and that was to drop the “Resharpener” type since this was based on microscopic analysis looking for use wear. This type was replaced with a “Uniface Retouch” category. Thus bifacial retouch flakes with use wear were moved to the Bifacial Thinning type and uniface retouch with wear moved to the new category. The only difference this made to Figure 1 was to lower the dividing line between “Bifacial Thinning” and “Resharpener”.

Figure 1: Ontario Flake Typologies

Shatter	Lennox (1986)			Flake Fragment		
	Primary	Secondary				
Shatter	Timmins (1997)					
	Primary Reduction	Secondary Reduction	Bifacial Retouch	Tool Resharpener		
Shatter	Keron (1986)			Flake Fragment		
	Cortex	Reduction			Bifacial	
Found in Ellis (1984)		Deller and Ellis (1992)			Flat Flake	Other Flake
		Channel	Normal	End Biface		
		Reduction error	Finishing	Ventral Uniface	Normal Uniface	

The third major assignment requested for each flake was a macroscopic assessment of the chert source. The vast majority of the types in the samples provided was composed of Kettle Point, Onondaga, and local till chert. The assignment was left open ended and the analysts were specifically requested to identify other exotic chert they recognized (e.g., Bayport, Flint Ridge, Upper Mercer etc.). A final category was left for burned or unidentifiable specimens. Each analyst was provided a standard form to record the results.

RESULTS

When the resulting forms were returned the results were entered into a series of spreadsheets, one for each of the two typologies and a third for the chert source analysis. One row was provided for each of the 200 flakes and four columns were provided for the four experienced analysts and finally a series of statistics was calculated. When two additional analysts were added later in the project, another set of spreadsheets was used comparing them to two of the original four analysts. It might have been possible to expand the existing spreadsheets but the complexity of the summary statistics increased exponentially with the number of analysts. Further, the two additional analysts were not asked to try and type the chert source since they had no previous experience and chert source identification is still primarily an oral tradition despite the publication of detailed descriptions such as Janusas (1984) or Eley and von Bitter (1989). The statistics calculated are presented as Tables 1 through 6 and a description of these follows.

Assemblage Frequency

Tables 1, 3 and 5 show the entire assemblage broken down into the percentage for each type for each analyst. In effect each column is that analysts determination of the percentages of that particular type in the collection. In theory, it is the same collection so the results should be identical. The columns show the breakdown for each analyst and the individual boxes show the percentage for that type. A vertical column will sum to 100%. Thus by scanning across this table, the assignments to type for the various analysts can be compared. For instance in Table 1, the frequency of Kettle Point chert varies from 17.5 to 19.5 to 27.5 to 23.5 for Analysts A through D respectively.

Agreement Between Analysts

Tables 2, 4 and 6 actually contain two sets of measurements describing the extent to which the analysts agree with each other. The box on the left shows the percentage of the assemblage that each listed pair of analysts agreed upon. For example in Table 2, Analysts A and B agreed on 61% of the collection or 122 of the 200 individual flakes. The box on the right shows the average number of analysts agreeing on a particular flake type if any agreement occurred at all. Thus, if there was any agreement on a flake as to its being Kettle Point chert then the average agreement was 3.48 analysts. The qualification that "if there was agreement" notes the fact that if all four analysts disagreed with each other that does not get averaged in as an agreement of 1. To count in this measurement, at least two people had to agree.

OBSERVATIONS

Upon examining the results of the experiment, several general trends are immediately apparent. First of all, there in fact does seem to be some significant differences between the various analysts such that one might legitimately then question a great deal of the analysis that has been published to date especially when you examine the statistics that show that any pair of analysts might only agree on 60% of the assemblage (Tables 2,4,6). The following discussion examines each of the three typologies looking closer at the results and will consider the meaning of these differences.

Chert Source Analysis

In examining the results of the exercise in macroscopic chert source identification the following general observations can be noted.

1. In general, the overall trends in the total assemblage analysis are similar between the four analysts. A predominance of Onondaga is followed by a smaller but still significant amount of Kettle Point chert and a trace of Selkirk chert. However, the percentages show some not insignificant deviation.
2. One factor which skews the results is the tendency of the analyst to leave some flakes unidentified. This varies from a high of 27.5% down to a low of 5%. When a large percentage is unidentified, the other identified categories are lower in relative percentage.
3. Another skewing factor is the confidence of some analysts in identifying local till chert. In fact, the more experience that an analyst has in the local area including these two sites, the more confidence he has in identifying local till chert. It is not surprising that the analyst scoring the highest has a collection of naturally occurring chert in the specific study area.
4. Given the more distinct nature of Kettle Point chert, it is surprising that there is as much variability in the frequency varying as it does from 17.5% to 27.5%.
5. Looking at the agreement between analysts analysis (Table 2, left side), it seems highly surprising that the percentages are as low as they are. What is even more surprising is that they cluster so tightly around 60%.
6. In looking at the average agreement by type (Table 2, right side), not unsurprisingly, the greatest agreement occurs on Kettle Point chert at 3.48 analysts.
7. Agreement as to the other chert types declines with local till chert being the lowest agreement which is to be expected given the different confidence between the various analysts in identifying it. Selkirk agreement may not be as bad as it looks. One analyst, (B), although recognizing it as a different source, explicitly stated that he lumps this in with Onondaga. Thus, the real agreement is 2.33 out of 3.

In general, the results of this are close to what was expected as far as the distinction between Onondaga and local till chert. In fact, three of the analysts have explicitly recognized the difficulty in telling these apart and in previous analyses have, while recognizing the difference, lumped local till chert and Onondaga into a single category (Keron 1986, Lennox 1995, Timmins 1997). In fact if that were done with the material in the experiment, the range of frequency variation in Table 1 would be greatly reduced. The down side of this though is that an important distinction between higher quality Onondaga traded in from the primary sources and the lower grade secondary sources is lost as an analytical distinction. Despite the hesitancy of these analysts to make a distinction, other analysts claim to be able to tell the difference and list both types with the relative frequencies of each. (e.g. Poulton 1985).

Table 1: Chert Source Analysis
Assemblage Frequency by Analyst

	Analyst A	Analyst B	Analyst C	Analyst D
Kettle Point	17.5	19.5	27.5	23.5
Onondaga	51	67	41	47
Selkirk	2	0	1.5	1.5
Local Till	1	7.5	16	19
Unidentified	27.5	5	13.5	8
Other Sources	1	1	.5	1

Table 2: Chert Source Analysis
Comparison of agreement between Analysts

Percent Agreement for Total Assemblage (x/200*100)		Average Agreement by Chert Type	
A to B	61	Kettle Point Chert	3.48
A to C	57.5	Onondaga Chert	3.05
A to D	56	Selkirk Chert	2.33
B to C	58.5	Local Till Chert	2.24
B to D	60	Unidentified	2.19
C to D	69	Other Chert	-

Another source of confusion which makes comparison between published analyses difficult is chert that is “unidentified”. This can occur for two reasons. First, the particular flake may have been burned and thus so altered that a source type assignment is not possible. The second reason is that, although the specimen is otherwise unaltered and in reasonable shape, the analyst is not confident enough to make a type assignment. It should be noted here that the study unfortunately did not make a distinction between these with the result that the same category was used for both. This complicates comparison since the percentages vary depending on the use of the “unidentifiable” category. Also where much burned and unidentifiable chert is present, a case could be made to pro rate the typed frequencies up to 100 assuming that all chert type flakes were equally likely to be burned.

Lennox Flake Type Analysis

One point that should be noted is that for both the stage typologies there are now six analysts involved, the four original and two new analysts with no prior experience in typing flakes. These

analysts were not required to type the source since chert source recognition is an oral tradition in archaeology.

1. Amongst the four experienced analysts, while there is some variability in the numbers for the flake typology, the percentages across the various analysts are roughly comparable. Surprisingly, there is more correspondence with these than there is with the chert typology.
2. The two novice analysts differ significantly from the four experienced analysts. In general, the percentage of primary is lower while secondary and shatter are higher than the other analysts.
3. A number of analysts identified cores, tools and, in one case, even a projectile point in the "debitage" collection. Most surprisingly there was little agreement amongst these so-called formal artifacts.
4. Looking at the agreement between analysts (Table 4 left side) again there is a surprising level of disagreement. Again, the experienced analysts cluster in around 60% agreement with respect to the entire assemblage. This seems a little surprising given the reasonable level of concurrence between the total assemblage analysis.
5. The inexperienced analysts have a much lower level of agreement with the other analysts and even each other. It should be noted though that the highest level of agreement they achieve is with each other which implies that they are making somewhat similar decisions. In this case with four categories pure random chance would result in 25% agreement less than the 42% actually agreed upon.
6. In looking at the average agreement per flake (Table 4, right side), the four primary types from the typology all come out with an average agreement of close to 3 analysts (only the four experienced analysts were used to calculate this).
7. What seems most surprising is that there is less agreement as to what constitutes a core than there is as to the four flake types. The average agreement here is only 2.4.

Despite the fact that people only seem to agree on 60% of the of the entire assemblage, the percentages for the flake types was not too far from agreement.

Timmins Flake Type Analysis

In examining the results of the comparison of the Timmins typology it should be noted that many of the same observations apply here that were noted for the Lennox typology. As these were discussed above they will not be repeated and only new or changed observations will be noted.

1. The results of the assemblage frequency analysis are similar to the previous typology. They are generally in alignment between the four experienced analysts.

2. Looking at the Agreement Between Analysts, it should be noted that the percentage of the assemblage upon which people agree has dropped by a noticeable amount.
3. The average agreement per flake has also dropped but only slightly. It is just below three now.
4. The fact that the agreement between analysts has dropped would seem to be at odds with the fact that the assemblage frequencies are roughly comparable between analysts and this duplicates the situation from the Lennox typology.

Table 3: Lennox Typology Analysis
Assemblage Frequency by Analyst

	Analyst A	Analyst B	Analyst C	Analyst D	Analyst E	Analyst F
Primary	42	33	32.5	37.5	17.5	15.5
Secondary	16	26.5	25.5	17	39	28.5
Fragment	26	25.5	29.5	30	19.5	26.5
Shatter	7	9	12	10	23.5	12.5
Core	2	3.5	.5	4.5	0	.5
Misc	7	.5	0	.5	.5	16.5
Artifacts	0	2	0	.5	0	0

Table 4: Lennox Typology Analysis
Assemblage Frequency by Analyst

Percent Agreement for Total Assemblage (x/200*100)		Average Agreement by Flake Type Analysts A, B, C and D Only	
A to B	60	Primary	3.48
A to C	60	Secondary	3.05
A to D	57.5	Fragments	2.33
B to C	62	Shatter	2.24
B to D	62	Cores	2.19
C to D	60.5		
A to E	36		
A to F	34.5		
E to F	42		

Table 5: Timmins Typology Analysis
Assemblage Frequency by Analyst

	Analyst A	Analyst B	Analyst C	Analyst D	Analyst E	Analyst F
Primary	16	11.5	20.5	17.5	14	10
Secondary	30.5	23	23	21	11	11
Biface Thinning	14	14	14	16	8	13
Resharpener	1.5	1	1	0	16	10.5
Fragment	26	29	29	30	19.5	26.5
Shatter	8	12	12	10	23.5	11.5
UID/other	6.5	.5	.5	5.5	.5	17.5

DISCUSSION

In some sense the results of this exercise are a little disturbing as the level of agreement on any given piece of debitage is low enough to call much published material into question. On the other hand, the assemblage frequency results are generally comparable.

There are several sources of error that need to be considered and the first of these is natural human error. Looking over the individual flake assignments by the various analysts, it became evident that this was one factor which led to variability in the results. One issue is likely that the numbers printed on each flake were only as large as the flake would allow and there was likely some misreading of the numbers either through poor printing or through looking the wrong way up (e.g. 6 or 9). Each analyst reported one or two flakes as missing from the sample but subsequent analysts found it and then reported another one missing. Further, typing of some flakes was difficult as they were very small and would not even have been retained in a quarter inch screen. These small flakes can lead to some eye strain and the striking platforms if present are very small indeed. As a large part of the typology rests on the striking platform these would be very difficult to assign without magnification. While difficult to actually quantify, it is felt that this source of error did not result in most of the observed variability although it likely did account for one to two percent of the variability. The majority of the flakes were larger and the numbers would not easily allow upside down reading as they were grouped in definite ranges so that 118 and 811 would not occur in the same bag. The bags were numbered and the bag numbers were on each input form along with a list of the exact catalog numbers included in the bag.

Another source of error may result from the fact that the definitions in the published articles are not necessarily complete. These descriptions are included as a brief description of the typology in a standard site report and not as an exhaustive definition in its own right. However, these were the definitional references identified by the authors themselves. I am not aware of exhaustive definitions with the possible exception of Ellis (1984). This deficiency in the definitions was neatly demonstrated by the last minute inclusion of two inexperienced analysts who while they understood

the basic principles of flint knapping and were provided the published description of the types still made a set of choices quite different from the experienced analysts. This leads to the conclusion that flake typology is very much a learned skill and much of the learning is passed on through oral tradition since the experienced analysts used information that was generally agreed upon but not necessarily published. Other attributes or decision points were used besides what was published. Differences in the learning of the oral tradition likely account for some more of the errors that occur but whether or not this could be improved is difficult to say and will require another iteration of the experiment. It may be possible to improve definitions and general agreement as to what each flake should be typed as but this would only be the case amongst the analysts involved and it is highly unlikely that kind of rigorous standardization will ever be achieved in archaeology.

Table 6: Timmins Typology Analysis
Assemblage Frequency by Analyst

Percent Agreement for Total Assemblage (x/200*100)		Average Agreement by Flake Type Analysts A, B, C and D Only	
A to B	49	Primary	2.74
A to C	58.5	Secondary	2.88
A to D	55	Biface Thinning	3.16
B to C	51	Fragment	2.96
B to D	55.5	Shatter	2.7
C to D	60	Cores	2.6
A to E	25		
A to F	28		
E to F	29.5		
E to D	33		
F to D	28.5		

A further source of error undoubtedly falls in the nature of the process itself and the nature of the materials with which we are working. Sullivan and Rozen (1985) note that lithic reduction is a continuum. As such there would be no clear boundaries between the stages and consequently between the types despite the fact that the archaeological concept of type usually includes the connotation that there is a fixed boundary between it and all other types. Introductory courses teach the battleship curve where the distinct type comes into existence as a minority, becomes popular and then drops to a minority again before finally dying out altogether. The gradual evolution of one type into another while sometimes recognized is not usually part of the concept of type probably because the human mind prefers distinct boundaries. Much typology is applied across a continuous range of human variation and despite the lack of clear boundaries is still a valid analytical concept which serves to organize the world into comprehensible units. What is necessary is to make sure that the

significance of the results of the analysis is not pushed beyond what the data are capable of bearing.

As it relates to this exercise, the lack of clear boundaries between the types undoubtedly leads to another source of error. If a continuous variation of flaking detritus is carved up into four types and if these types are rigorously defined and well communicated, then it seems reasonable that each type is focused at a specific point along the continuum or possibly range of the continuum. Thus if a flake falls neatly onto one of the defined points then most analysts should agree as to which type it is. Suppose, however, that it falls at a point exactly equidistant between the defined points. In this case faced with the topological concept that the flake must conform to some predefined type an analyst will assign it to one or the other of the adjacent types. At this point any agreement between analysts may be strictly fortuitous with an equal chance of either adjacent type being assigned depending on which attributes the analyst sees or emphasizes. As one moves along the continuum agreement will improve until the definition point of the type is passed where it will tend to decrease again until mid way towards the next definition on the other side. To put this into probabilistic terms, if there is complete agreement on half the sample and a fifty-fifty chance of agreement on the other half, an overall agreement between two analysts would come out at 75% of the entire sample, a situation not too far above observed values. Further given a reasonably large sample, it is to be expected that these differences of opinions would tend to average out which would mean that the overall assemblage percentages would be not be too different which again is what tends to occur with the data presented here.

In order to deal with this it is necessary to recognize the essentially probabilistic nature of the frequencies that are generated (Tables 1,3 and 5). This inference is in accord with our observations that show that analysts roughly agree about the overall nature of the assemblage but that there is a variability in the frequencies that they identify. This variability can be expected to occur around a mean value that could be calculated if a large number of analysts were to examine the same sample. Further as the number of pieces of debitage increases the variability in the frequencies of the various analysts would be expected to decrease (as long as any systematic error is removed). What this means is that the frequencies generated by a single analyst would be better expressed as a confidence interval, for example, the frequency of Kettle Point chert for Analyst D is not 23.5% but $23.5 \pm 4.6\%$. The challenge then becomes to find a method to develop this confidence interval from a small sample.

At this point in time a detailed mathematical derivation of this value is beyond the scope of this paper and discussion with statisticians (Wonnacott, pers comm. 2000) indicate that it may also be beyond the author's mathematical skills. However, a minimum value can be observed by examining Tables 1, 3 and 5. From Table 1 only the values associated with Kettle Point chert will be used because of the skewing factors noted above with other types. From Table 2, the first three rows will be used and from Table 5, the first three rows will also be used. If we assume that the analysis done by the experienced analysts is valid except for the probabilistic nature of the process, then almost all values for the selected rows should cover the real value of the population with a confidence interval. In order to approximate a minimum value for the standard error, the mean of each row included was calculated. Secondly the absolute value of the differences between each value and the associated mean is calculated. A minimum value for the confidence interval then will be the largest absolute value for any row which is 6.6 in Table 5, Analyst B, Bifacial thinning. Thus any given

frequency above 12.5% should have a plus or minus factor of at least 6.6 factored in before comparison is attempted.

CONCLUSIONS

In considering the results of this experiment, the most obvious conclusion is that using published analyses from different analysts can be problematic. However, as has been shown, if these are treated as probabilistic in nature and a confidence interval is assigned to them, the numbers can be used provided one has confidence in the experience of the analyst. The comparison of flake typologies though is further complicated when different typologies are used. However, it should be possible through careful analysis of the definitions to develop a comparison chart much like Figure 1. The only limitation is that while more complex typologies can be converted to simpler typologies, the reverse is not true. (e.g. Timmins typology could be converted to Lennox's typology but not the reverse.)

In examining chert source analysis from published sources, great care should be taken as relates to the distinction between Onondaga chert and local till chert. As has been shown in the analysis, the frequencies of these can yield significantly different results depending on the experience that the analyst has in the particular study area where the sites are located. If a distinction is made then no comparison should be attempted except with analyses done by the same analyst. If it is necessary to use published information, then the percentages of Onondaga and local till chert should be added together.

Thus we have seen that, while significant discrepancies do exist between observers, error factors contributing to these can be minimized and that, with a proper allowance for inter observer error, published analyses can be compared validly.

Acknowledgements

The author would like to thank Dr. Andrew Nelson and Dr. Chris Ellis for reviewing earlier drafts of this paper, also for time spent in discussing the ideas contained herein. Also mentioned should be Paul Lennox, Dr Peter Timmins and Bill Fox who aided and abetted the author's adoption of the oral traditions of lithic analysis over the years.

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